

### **Amendments to the Claims**

This listing of claims will replace all prior versions, and listings of claims in the application:

#### **Listing of Claims:**

Claim 1 (Original): A phase contrast system for synthesizing an output electromagnetic field  $u(x'', y'', z'')$ , comprising

a first phase modifying element for phase modulation of an input electromagnetic field by phasor values  $e^{i\phi(x,y)}$ ,

first Fourier or Fresnel optics for Fourier or Fresnel transforming the phase modulated electromagnetic field positioned in the propagation path of the phase modulated field,

a spatial filter for filtering the Fourier or Fresnel transformed electromagnetic radiation by

in a region of spatial frequencies comprising DC in the Fourier or Fresnel plane

phase shifting with a predetermined phase shift value  $\theta$  the modulated electromagnetic radiation in relation to the remaining part of the electromagnetic radiation, and

multiplying the amplitude of the modulated electromagnetic radiation with  
a constant  $B$ , and

in a region of remaining spatial frequencies in the Fourier or Fresnel plane,

multiplying the amplitude of the modulated electromagnetic radiation with  
a constant  $A$ ,

second Fourier or Fresnel optics for forming an electromagnetic field  $o(x', y')$  by  
Fourier or Fresnel transforming the phase shifted Fourier or Fresnel transformed  
electromagnetic field, and

a second phase modifying element for phase modulating the electromagnetic  
field  $o(x', y')$  into the electromagnetic field  $o(x', y')e^{i\Psi(x', y')}$  propagating as the desired  
output electromagnetic field  $u(x'', y'', z'')$ .

Claim 2 (Original): A phase contrast system according to claim 1, wherein at least one  
of the first and second phase modifying elements is further adapted for phase  
modulation by first phasor values for a first polarization and second phasor values for a  
second orthogonal polarization of the input electromagnetic field.

Claim 3 (Original): A phase contrast system according to claim 2, wherein the second phase modifying element is further adapted for phase modulation by first phasor values  $e^{i\psi_1(x', y')}$  for a first polarization and second phasor values  $e^{i\psi_2(x', y')}$  for a second orthogonal polarization of the input electromagnetic field.

Claim 4 (Currently Amended): A phase contrast system according to claim 2 [[or 3]], further comprising an element for directing the phase modified orthogonal fields into separate paths of propagation, e.g. to be applied in a non-interfering counter-propagating geometry.

Claim 5 (Currently Amended): A phase contrast system according to claim 1 ~~any of the preceding claims~~, wherein

$$A = 1.$$

Claim 6 (Currently Amended): A phase contrast system according to claim 1 ~~any of the preceding claims~~, wherein

$$B = 1.$$

Claim 7 (Currently Amended): A phase contrast system according to claim 1 ~~any of the~~  
~~preceding claims~~, wherein

$$\theta = \pi.$$

Claim 8 (Currently Amended): A phase contrast system according to claim 1 ~~any of the~~  
~~preceding claims~~, wherein the phasor values  $e^{i\phi(x,y)}$  of the first phase modifying element  
 and the phase shift value  $\theta$  substantially fulfil that

$$o(x', y') \cong A \left[ \exp(i\tilde{\phi}(x', y')) + K \bar{\alpha} (BA^{-1} \exp(i\theta) - 1) \right]$$

wherein

$A$  is an optional amplitude modulation of the spatial phase filter outside the zero-order  
 diffraction region,

$B$  is an optional amplitude modulation of the spatial phase filter in the zero-order  
 diffraction region,

$\bar{\alpha} = |\bar{\alpha}| \exp(i\phi_{\alpha})$  is the average of the phasors  $e^{i\phi(x,y)}$  of the resolution elements of the  
 phase modifying element, and

$$\tilde{\phi} = \phi - \phi_{\alpha}, \text{ and}$$

$K = 1 - J_0(1.22\pi\eta)$ , wherein

$J_0$  is the zero-order Bessel function and

$\eta$  relates the radius  $R_1$  of the zero-order filtering region to the radius  $R_2$  of the main-lobe of the Airy function of the input aperture,  $\eta = R_1 / R_2 = (0.61)^{-1} \Delta r \Delta f_r$ .

Claim 9 (Currently Amended): A phase contrast system according to claim 1 ~~any of the preceding claims~~, wherein the phase shift value  $\theta$  substantially fulfills the equation

$$K|\bar{\alpha}| = \frac{1}{2|\sin \theta / 2|}.$$

Claim 10 (Currently Amended): A phase contrast system according to claim 1 ~~any of the preceding claims~~, wherein at least one of the first and second phase modifying element comprises a complex spatial electromagnetic field modulator that is positioned in the path of the input electromagnetic field and comprises modulator resolution elements  $(x_m, y_m)$ , each modulator resolution element  $(x_m, y_m)$  modulating the phase and the amplitude of the electromagnetic field incident upon it with a predetermined complex value

$$a_m(x_m, y_m)e^{i\phi(x_m, y_m)}.$$

Claim 11 (Currently Amended): A phase contrast system according to claim 1 ~~any of the preceding claims~~, further comprising a light source for emission of the input electromagnetic field, the light source comprising a laser array, such as a VCSEL array.

Claim 12 (Currently Amended): An optical micro-manipulation or multi-beam optical tweezer system ~~according to any of the preceding claims~~ including the phase contrast system of claim 1.

Claim 13 (Currently Amended): A laser machining tool ~~according to any of the preceding claims~~ including the phase contrast system of claim 1.

Claim 14 (Currently Amended): A method of synthesizing an output electromagnetic field  $u(x'', y'', z'')$ , comprising ~~the steps of:~~

phase modulating an input electromagnetic field by phasor values  $e^{i\phi(x,y)}$ ,

Fourier or Fresnel transforming the phase modulated electromagnetic field,

filtering the Fourier or Fresnel transformed electromagnetic radiation by

in a region of spatial frequencies comprising DC in the Fourier or Fresnel plane

phase shifting with a predetermined phase shift value  $\theta$  the modulated  
electromagnetic radiation in relation to the remaining part of the  
electromagnetic radiation, and

multiplying the amplitude of the modulated electromagnetic radiation with  
a constant  $B$ , and

in a region of remaining spatial frequencies in the Fourier or Fresnel plane,

multiplying the amplitude of the modulated electromagnetic radiation with  
a constant  $A$ ,

forming an electromagnetic field  $o(x', y')$  by Fourier or Fresnel transforming the phase  
shifted Fourier or Fresnel transformed electromagnetic field, and

phase modulating the electromagnetic field  $o(x', y')$  into the output electromagnetic field  
 $o(x', y')e^{i\psi(x', y')}$  propagating as the desired output electromagnetic field  $u(x'', y'', z'')$ .

Claim 15 (Currently Amended): A method according to claim 14, further comprising the steps of:

dividing the electromagnetic field  $o(x', y')$  into pixels in accordance with the disposition of resolution elements  $(x, y)$  of a first phase modifying element having

a plurality of individual resolution elements  $(x, y)$ , each resolution element  $(x, y)$  modulating the phase of electromagnetic radiation incident upon it with a predetermined phasor value  $e^{i\phi(x,y)}$ ,

calculating the phasor values  $e^{i\phi(x,y)}$  of the phase modifying element and the phase shift value  $\theta$  substantially in accordance with

$$o(x', y') \cong A \left[ \exp(i\tilde{\phi}(x', y')) + K |\bar{\alpha}| (BA^{-1} \exp(i\theta) - 1) \right]$$

wherein

$A$  is an optional amplitude modulation of the spatial phase filter outside the zero-order diffraction region,

$B$  is an optional amplitude modulation of the spatial phase filter in the zero-order diffraction region,

$\bar{\alpha} = |\bar{\alpha}| \exp(i\phi_{\alpha})$  is the average of the phasors  $e^{i\phi(x,y)}$  of the resolution elements of the



phase modifying element, and

$$\tilde{\phi} = \phi - \phi_{\alpha}, \text{ and}$$

$$K = 1 - J_0(1.22\pi\eta), \text{ wherein}$$

$J_0$  is the zero-order Bessel function, and

$\eta$  relates the radius  $R_1$  of the zero-order filtering region to the radius  $R_2$  of the main-lobe of the Airy function of the input aperture,  $\eta = R_1 / R_2 = (0.61)^{-1} \Delta r \Delta f_r$ ,

selecting, for each resolution element, one of two phasor values which represent a particular grey level, and

supplying the selected phasor values  $e^{i\phi(x,y)}$  to the respective resolution elements  $(x, y)$  of the first phase modifying element, and

supplying selected phasor values  $e^{i\psi(x',y')}$  to respective resolution elements  $(x', y')$  of a second phase modifying element having a plurality of individual resolution elements  $(x', y')$ , each resolution element  $(x', y')$  modulating the phase of electromagnetic radiation incident upon it with the respective phasor value  $e^{i\psi(x',y')}$  for generation of the output field  $o(x', y')e^{i\psi(x', y')}$ .